LS
MISC.

400115

RI-LS
SOIL RELATIONS
Moisture,
(Variability)

April 29, 1958

# WORK PLAN

for

# AN EXPERIMENTAL STUDY OF SOIL MOISTURE VARIABILITY AT THE BEGINNING OF THE GROWING SEASON UNDER FORESTED AND NON-FORESTED CONDITIONS

by

W. B. Striffler

## Work Schedule

This study is scheduled for accomplishment during the week of May 5 - 9. Total man days involved are broken down as follows:

| Item | Man-Days |
|---|---|
| Sampling and plot layout | 2 |
| Lab processing of samples | 2 |
| Computations | 1 |
| Analysis and write-up | 3 |
| Total | 8 |

No estimate of costs will be made for this study due to the short time required. In fact, no costs other than man-days are involved. No decision as to publication of this study will be made prior to its completion.

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# AN INFORMAL STUDY OF SOIL MOISTURE VARIABILITY AT THE BEGINNING OF THE GROWING SEASON UNDER FORESTED AND NON-FORESTED CONDITIONS

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## Introduction

For many years foresters, hydrologists, agriculturalists, and others faced with the task of sampling the moisture in the soil, have come up against the problem of determining the minimum sampling required to give an adequate measure. Especially in research has the problem of determining the variability of soil moisture become apparent. All too often researchers have conducted studies with an inadequate sampling design with the result that data is either worthless or so insensitive that the margins of error, shown by statistical analysis, prevent an adequate comparison of the plots sampled. This problem is further complicated by the fact that the measurement of soil moisture is a time-consuming difficult job in which the sampling adequacy is often influenced by financial considerations.

Many factors contribute to the variability of soil water. These factors may be grouped under three headings; climatic, vegetative, and edaphic. Climatic factors include the season of the year (i.e. dry or wet), the distribution of precipitation, and such modifying characteristics as temperature, humidity, and wind. Vegetative factors are, perhaps, most significant in their effects upon interception, through fall, stream flow, evaporation,

transpiration, and the distribution of moisture within the soil profile. Edaphic or soil factors are also important and include such factors as soil texture, structure, organic contents, stone contents, etc., which exert an influence upon the percolation, distribution, and retention of soil water.

A knowledge of the variability of soil moisture is essential to the design of any soil moisture study as well as to the determination of sampling intensity. It is possible that variability may vary with depth in such a manner that fewer samples are required from the lower depths, thus saving time and money. It is also possible that variability may be less under non-forested conditions as compared to forested conditions, again requiring fewer samples and permitting a more efficient sampling design. It is with these thoughts in mind that this study is undertaken.

## Scope of Studies

The purpose of this study is to investigate the variability of soil moisture at the beginning of the growing season under forested and non-forested conditions. The site chosen for this study is an area in the Manistee National Forest. Two one-acre plots have been established, one forested with a cover of scrub oak, the other non-forested, with a fairly uniform cover of grasses. Both plots are on the same soil, a Grayling sand, which appears to be homogeneous throughout the sampling area.

The study is designed to give a fairly intensive sampling over an acre of ground from which the variability of that particular acre will be determined. Since sampling is by depth intervals, i.e. 0-1, 1-2, 2-3, 3-5, and 5-7 foot intervals, a comparison of soil moisture variability between depth intervals is also possible. Thus a two-way comparison is possible between depths within plots and by depths between plots.

A third comparison of variability will also be examined in this study. This will be an examination of the reliability of an intensive point sampling as an estimate of the parameters of soil moisture over an area. In other words, will an intensive sampling of a small sub-plot give an adequate measure of the moisture for the entire plot. This will be accomplished by establishing two small sub-plots in each plot and sampling each systematically and intensively. This will in effect give a comparison of point sampling versus area sampling, a problem often encountered in electrical-resistance sampling methods.

## Methods

As previously stated, two plots have been selected, one a forested "scrub oak" plot, the other a non-forested "grass" plot. Both plots are on apparent homogeneous deep sand soil with very little profile development. Plots are one acre in size being 2 1/2 x 4 chains. A 1/2 chain grid is super-imposed upon each plot giving a total of forty 1/2 chain squares. Each square represents a sampling area, the center of each square being the sampling point. Figure 1 shows the sampling design. A total of forty samples will be taken from each plot for the area sample. Two small sub-plots will be established in each plot. The Number 1 and Number 40 squares on the grid will represent these sub-plots. A total of 9 samples will be taken from within a 4-foot radius of the center of each sub-plot. Figure 2 shows the sampling design for these "point" moisture determinations.

Soil moisture sampling will be gravimetric with the Veihmeyer tube. Samples will be taken to a depth of 7 feet from 0-1, 1-2, 2-3, 3-5, and 5-7 foot intervals. Samples will be collected in airtight cans and taken to the laboratory. Moisture contents are determined by weighing the fresh sample,

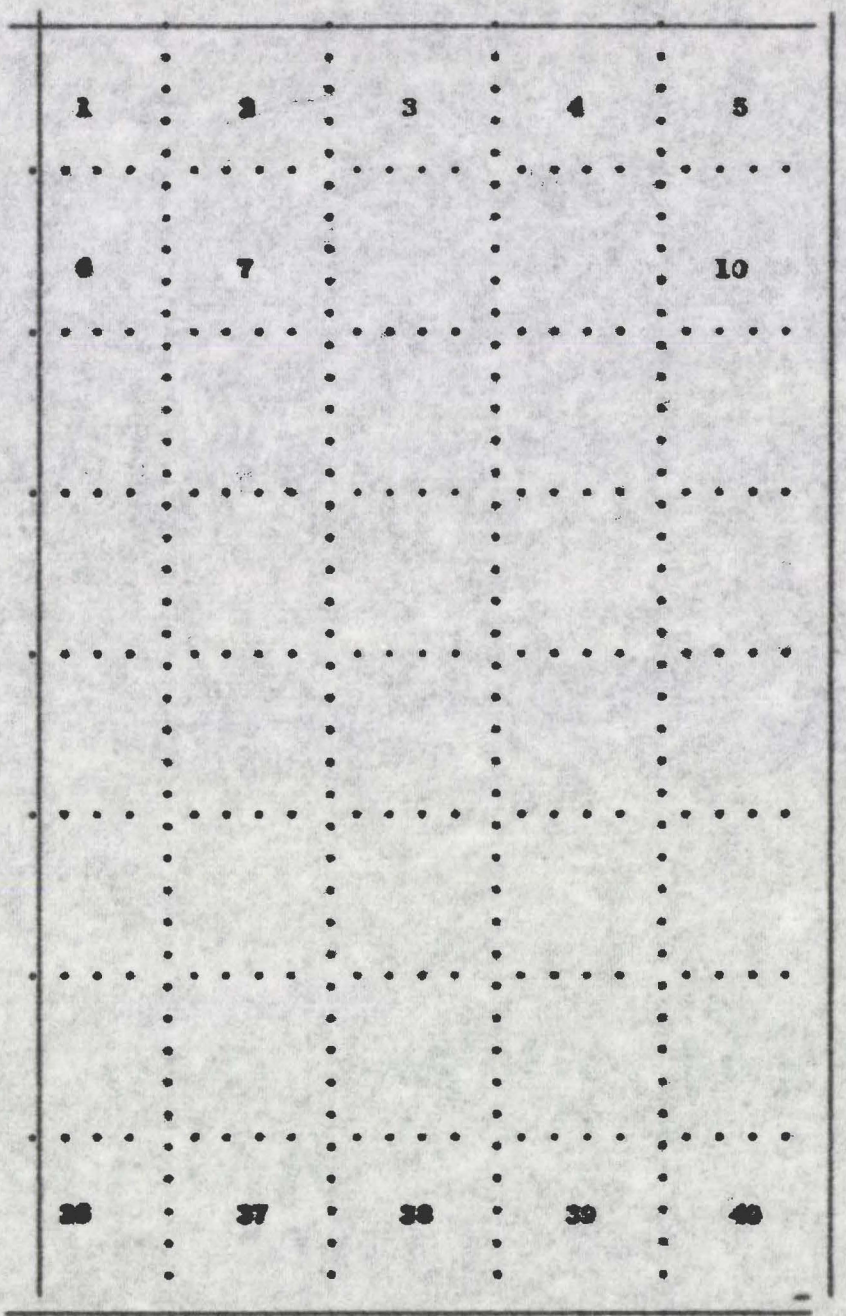


Figure 1. Sampling design and plot layout. Plot is $2\frac{1}{2}$ x 4 chains with a $\frac{1}{2}$ chain grid overlay indicated by the dotted lines. The center of each $\frac{1}{2}$ chain square represents the point of sampling.

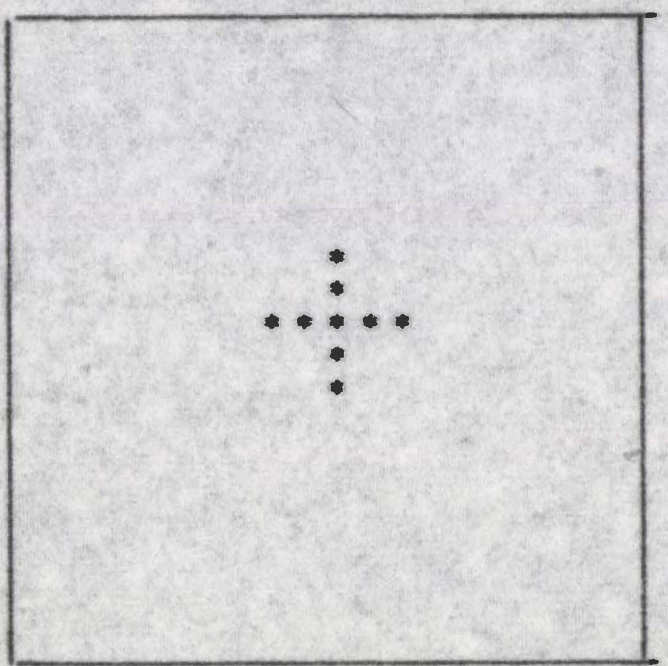

Figure 3. Sampling design for point sample. Each asterisk indicates a point of sampling. Sampling points are two feet apart or within a maximum radius of four feet from the center. Two such samples will be taken from each plot. The sub-plot illustrated is $\frac{1}{4}$ chain square.

drying the sample for twenty-four hours at 105°C., re-weighing and expressing the loss of weight or moisture as a percentage of oven-dry weight. Stone is excluded from these oven dry weights. Field Form #1 will be used as a field, laboratory and computation form for determining moisture contents.

## Analysis

Analysis of soil moisture variability will primarily be by comparison of standard deviation values. As previously stated, comparisons will be between soil depths within plots and by soil depths between plots. Another comparison will be between point and areal standard deviations both within plots and between plots. As another means of comparisons, coefficients of variation will be determined for each value to be compared; in other words, a coefficient of variation will be determined for the aggregate variation of each soil depth on each plot, for the variation by soil depth at each point sample, and for the total variation, both point and areal, on each plot. The coefficient of variation may be computed as follows:

$$C = s/\bar{x} \quad \text{1/}$$

in which $s$ is the standard deviation and $\bar{x}$ the mean moisture content of the soil depth concerned.

Coefficients of variation have the advantage of permitting a comparison of values from different populations. For example, if the level of soil moisture in the non-forested plot is higher than in the forested plot, as would be likely during certain seasons, the standard deviation of the non-forested plot would also tend to be larger. The coefficients of variation,

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1/ Snedecor, G. W., Statistical Methods, 5 ed. 1956. Sect. 2.16.

however, might be very close indicating little difference in relative variation. Another advantage of the use of "C" in this problem is that it is adaptable to a statistical analysis. Accordingly a test for "t" will be made on the mean coefficient of variation for both point and areal samples and between forested and non-forested plots. This will permit an analysis of the significance of variation in soil moisture variability.

As a final step in the analysis of this problem, minimum sampling intensities will be determined for each depth interval on each plot, both on a point and areal basis. This is accomplished by the use of the formula:

$$n = \frac{4s^2}{L^2} \quad 2/$$

in which n is the number of samples required to give parameter estimates within a 95 percent confidence limit, s is the estimated standard deviation, and L is the allowable error. In this study the allowable error will be considered to be 1 percent of moisture by weight. An additional test may be made with L equal to .5 percent of moisture by weight.

All results will be presented in a tabular form in such a manner that with plot comparisons between point and areal values, and between plot comparisons may be clearly defined.

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2/ Snedecor, G. W., Statistical Methods, 5 ed. 1956. Sect. 17.6.